Petrological and geodynamic evolution of the Late Cretaceous subduction-related volcanism in the eastern Sakarya Zone, NE Turkey

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Based on the volcanostratigraphic studies, zircon U-Pb dating and geochemical data, the Late Cretaceous volcanic rocks (LCVs) from the Artvin region in the eastern Sakarya zone (NE Turkey) consist of mafic/basaltic (S1-Çatak and S2-Çağlayan) and felsic/acidic (S1-Kızılkaya and S2-Tirebolu) rock types that occurred in two successive stages: (i) first stage (S1: Turonian to Early Santonian) and (ii) second stage (S2: Late Santonian to Campanian). In both stages, the basaltic rocks contain generally calcic plagioclase and lesser augite crystals, whereas the acidic samples commonly contain quartz, sodic plagioclase and K-sanidine phenocrysts. Data from clinopyroxene thermobarometry point to the S2-Çağlayan basaltic rocks having crystallised at higher temperatures and under deeper crustal conditions (T = 1128 ± 15 °C, P = 6.5 ± 0.7 kbar and D = 19.5 ± 2.1 km) than those of the S1-Çatak rocks (T = 1073 ± 11 °C, P = 2.2 ± 1.0 kbar, D = 6.6 ± 3.0 km).

The LCVs show a wide compositional spectrum, ranging from tholeiite to calc-alkaline/shoshonite and are typically represented by a geochemical composition resembling subduction-related arc rocks although the $^{87}\text{Sr}/^{86}\text{Sr}_{(i)}$ (0.7044–0.7071) and $^{143}\text{Nd}/^{144}\text{Nd}_{(i)}$ values (-0.63 to +3.47) as well as $^{206}\text{Pb}/^{204}\text{Pb}_{(i)}$ (18.07 to 18.56), $^{207}\text{Pb}/^{204}\text{Pb}_{(i)}$ (15.57 to 15.62) and $^{208}\text{Pb}/^{204}\text{Pb}_{(i)}$ (37.12 to 38.55) ratios show very limited variation. The average δ$^{18}$O isotope values of the S1-Kızılkaya (5.3 ± 0.5‰) and S2-Tirebolu (4.9 ± 0.8‰) zircons are quite consistent with average mantle values (5.3 ± 0.3‰). The similar isotopic compositions of the studied mafic and felsic volcanic rocks, and the relatively high Mg# values (up to 0.4–0.51) of the felsic samples indicate a cogenetic origin. The parent magmas of the S1-Çatak and S2-Çağlayan mafic volcanic rocks were derived from underplated basaltic melts that originated by partial melting of metasomatised spinel lherzolite and spinel-garnet lherzolite, respectively. It is proposed that the compositions of the S1-Kızılkaya (mainly dacitic) and S2-Tirebolu (rhyolitic to trachytic) felsic rocks were particularly controlled by metasomatised mantle–crust interaction and MASH zone plus shallow crustal fractionation processes.
Our data, together with data from previous studies, suggest that the S1- and S2-mafic and felsic rock types of the LCVs (~95–75 Ma) are the products of two-stage volcanic event that took place during the northward subduction of the northern Neotethys Ocean.

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